Unit 1 / 10 Days

Transportation Technology

Transportation systems are essential for all societies. The level of development of these systems will directly influence the standard of living of the citizens in society. Early transportation systems developed along natural trails developed by animals and dry stream beds, and on waterways. These natural environmental features often limited the areas where humans could develop settlements.

Later transportation systems became more complex as natural barriers were conquered. Canals were developed which could transverse changes in elevation; roads and railways were built to connect settlements; human flight was made possible; and finally, the reaches of space have been opened up with highly-engineered transportation systems.

Transportation has had, and will continue to have, a major impact on both our personal lives and society as a whole. From the establishment of new settlements to the opening up of entire continents, transportation has always been at the forefront of change. Wars have been won and lost on nothing more than the ability to move equipment and personnel. Cities came into being because of transportation systems, yet downtown areas are dying today because people are able to easily commute into metropolitan areas from distant suburbs. It is with this in mind that the importance of understanding transportation is so evident.

This unit is designed to introduce the students to the historical development and importance that transportation holds in both our personal lives and society as a whole. This will be done by studying the concepts of transportation as a system with inputs, processes and outputs. The content and activities are also aligned with the develop, produce, use and assess model common of technology-based programs. The learning experiences in this unit provide the basic foundation for the remainder of the course.

Objectives

Upon completing this unit each student will be able to:

- ✔ Define transportation
- ✔ Describe the importance of transportation to individuals and society
- ✔ Explain how technological developments have changed how goods and people are transported
- ✔ Explain the difference between personal and commercial systems
- ✔ Explain the develop-produce-use-assess model of technology and apply it to a given transportation systems
- ✔ Review and describe a local transportation endeavor or system

Proposed Schedule For The Unit

Day	Content / Activities
1-2	Organize the course Initiate the study of transportation technology Introduce a model of the transportation process
3-6	Cover the historical evolution of transportation technologies Review the development of vehicles & systems
7-8	Explore modern travel and commerce
9-10	Identify examples of the common developing, producing, using and assessing actions associated with transportation technologies

Outline For Unit #1

Day — Instructional Outline (Lessons / Activities / Notes)

1-2 Complete the administrative details associated with starting the class (seating charts, class procedures, grading, etc.) and then direct the focus to travel and transportation technology

1. Define what is meant by the terms “transportation” and “transportation system”
   - Movement of people and goods
   - Inputs, processes and outputs involved in allowing for the mass movement of people and goods
   - Cite how transportation also involves recreational travel (versus trying to get from Point A to Point B the most efficient way)
   - Note how human history is full of famous journeys, explorers, and accomplishments (such as landing on the moon)
2. Emphasize the role of transportation in getting students to school each day via various systems
3. Highlight the importance transportation holds in our society, including:
   - Personal
     - ✔ Family vehicles
     - ✔ Recreational vehicles (bicycles, skate boards, etc.)
   - Commercial
     - ✔ Passenger needs (individual and mass transit)
     - ✔ Movement of freight / goods / cargo
   - Government (national) needs
     - ✔ Military
     - ✔ Space exploration and research

Day Instructional Outline (Lessons / Activities / Notes)

- ✔ Global communication (e.g., GPS technology)
- ✔ Safety engineering (NTSB, FAA, etc.)

4. Explain the common elements of the transportation process using the model found in the class textbook for this lesson:
   - Routing
   - Loading
   - Moving
   - Navigation
   - Unloading
   - Storing / Retrieval
   - Management / planning / traffic engineering
5. Use a video to highlight modern transportation, such as media on a metropolitan subway or high-speed rail system
6. Based on the content of the video, develop a model of the transportation system on the board to highlight the input, process, and output elements

3-6 Review the historical evolution of transportation technologies

1. Use a formal presentation to introduce the importance of transportation starting with the earliest developments and concluding with modern times
   - Early examples include log-rafts floating down rivers, dragging materials along pathways, or riding on domesticated animals
   - The next stage of developments
     - ✔ Animal-drawn carts
     - ✔ Specialized boats
     - ✔ Gravity-based bins and chutes
     - ✔ Crude attempts to create railways, guideways, and conveyors
   - Developments of the next few centuries
     - ✔ New types of sails
     - ✔ Improved propulsion systems (internal combustion engine, rockets, hybrid systems, etc.)
     - ✔ Better pathways (paved roads, rail lines, tunnels, canal and lock systems on rivers, harbors, etc.)
     - ✔ Research into vehicle performance
     - ✔ Navigational aids
     - ✔ Passenger and freight system planning (i.e., logistics)
     - ✔ Other
   - Transportation in the 20th century
     - ✔ Powered (atmospheric) flight
     - ✔ Improved materials for vehicles (i.e., composites)
     - ✔ Manned and un-manned space systems
     - ✔ Growth in transportation services
     - ✔ Other

Day Instructional Outline (Lessons / Activities / Notes)

2. Have each student in the class research both a famous explorer or the crew of a journey or project, plus a famous vehicle, such as:
   - Explorers (that relied on present-day technologies)
     - ✔ Magellan
     - ✔ Columbus
     - ✔ Hook
     - ✔ Other
   - Journeys / Trips
     - ✔ Mission to the moon
     - ✔ Aviation accomplishments (non-stop and speed records, etc.)
     - ✔ Land speed records
     - ✔ Other
   - Famous vehicles
     - ✔ Covered wagons / prairie schooners / stage coaches
     - ✔ John Bull (and other railway engines)
     - ✔ Mayflower
     - ✔ Wright brother's aircraft / flyer
     - ✔ Otis safety elevator
     - ✔ Model T
     - ✔ Monitor and the Merrimac
     - ✔ Spirit of St. Louis
     - ✔ Pioneer Zephyr
     - ✔ Various warbirds of WWI and WWII
     - ✔ Mercury, Gemini, Apollo spacecraft
     - ✔ Boeing 707, 727, 747, 777 aircraft
     - ✔ Trans-Alaska pipeline
     - ✔ U.S.S. Nautilus
     - ✔ International space station
     - ✔ Segway (personal people-mover)
     - ✔ Other

   Note: There should be numerous links to social studies in this activity
3. Ask each student to report on their topics through a 3-5 minute oral presentation complete with illustrations (i.e., photocopies or renderings)
4. Reserve a wall or bulletin board in the classroom to establish a timeline for the evolution of transportation throughout history . . . . place markers to denote the 1500s, 1600s, 1700s, 1800, 1900s, etc. along the display
5. Place the graphics prepared by each student on the display in the appropriate era

   Note: Naturally, many famous vehicles and events will be missing, so enhance the time-line with important examples that have been left off the display (including examples that are found in the class textbook)
6. Plan to refer to the display as topics come up during the course

Day Instructional Outline (Lessons / Activities / Notes)

7-8 Explore modern travel (both personal and commerce activities)

1. Have each student select two places they might want to go on a vacation, one domestic (i.e., continental U.S.) and another someplace else around the globe
   Note: Try to direct the students in the class to each identify a different city, nation, or region
2. Allow the students to use travel websites (both mapping and commerce sites) to determine the (a) distance, (b) travel time, (c) routes, (d) costs, (e) etc. for the proposed trip
3. Conduct a show-and-tell period so that students can describe their proposed trips with modes, costs, or related details
   Note: This activity involves many links to mathematics, from schedules to pricing to distances

9-10 Review transportation using the D-P-U-A (design, produce, using, and assessing) model

1. Develop a form (worksheet) that asks each student to identify what types of vehicles and systems they have ever ridden in . . . . cars, elevators, school buses, bicycles, hot air balloons, canoes, subways, private planes, commercial jets, etc. Note: This should be a survey instrument (questionnaire) that has a master list of vehicles and systems
2. Provide a brief explanation of designing / producing / using / assessing model with a focus on transportation actions
3 Have each student select a vehicle or system, and place it in the middle of a D-P-U-A illustration
4. Ask each student to explain how their vehicle or system fits in the model, with a description of it was designed, who uses the vehicle or system, and impacts on the economy and environment
5. Conclude the introductory unit with some form of evaluation as appropriate

Evaluation

Students may be evaluated on these actions and related criteria . . . .

- ✔ Participation in classroom activities
- ✔ Individual efforts while researching various topics
- ✔ Quality of formal presentation
- ✔ Any media developed related to the D-P-U-A model
- ✔ Scores on teacher-created tests and quizzes

Unit #2 / 20 Days

Transportation Environments

Transportation systems are designed to operate in specific environments. Different transportation systems are designed to move people and cargo on land, on water, in air, and in space. Although all these systems have many similar components, each of the vehicles involve unique characteristics imposed by the physical environment in which they operate. Land systems must compensate for uneven terrain; marine systems the possibility of sinking; aviation systems the constant changes in the atmosphere; and space systems the harsh vacuum of orbital or distance space.

This second unit will allow the student to explore the various transportation environments (i.e., modes) and identify the similarities and differences between them. It will also look at the advantages and limitations of the various transportation systems in regards to the environments in which they operate.

Interestingly, technology educators are one of the few groups that separate the study of transportation by modes. Government officials often divide transportation into activities such as space travel (that is assigned to NASA, an agency not in the U.S. Dept. of Transportation) or marine systems (i.e., St. Lawrence Seaway, etc.). At the same time, most commercial delivery firms (Fed Ex, UPS, USPS, etc.) look at the challenge of moving materials first and then select the best mode within their networks.

By studying the environments in which transportation systems operate the students will be able to make informed decisions about the systems they use and the impacts they create. For instance, it might introduce a new marine technology for students attending a land-locked school. It might expose students to aviation technologies for a first time. Certainly it might produce more knowledgeable individuals who will be able to take an active role in the development and use of future transportation systems.

Objectives

Upon completing this unit each student will be able to:

- ✔ Identify the four common modes of transportation and describe the major characteristics for each environment
- ✔ Explain what is meant by intermodal transportation
- ✔ Differentiate between passenger and goods-moving systems
- ✔ Describe common facilities used in each of the transportation environments
- ✔ List the advantages and disadvantages of each of the transportation environments based on classroom and laboratory experiences

Proposed Schedule For The Unit

Day	Content / Activities
1	Introduce the modes of transportation
2-5	Explore land-based transportation vehicles and systems
6-10	Explore water-based (marine) vehicles and systems
11-13	Explore aviation vehicles and systems
14-17	Explore space-based transportation vehicles and systems
18-20	Explore intermodal vehicles and systems Conclude the unit with some form of evaluation

Outline For Unit #2

Day	Instructional Outline (Lessons / Activities / Notes)
1	Introduce how transportation involves the moving of people and goods in four environments 1. Common modes / environments ● On or under the (land) surface of the earth ● On or under water (typically called marine transportation in textbooks) ● Through the earth's atmosphere ● Into the voids of space (both orbital and interplanetary) Note: Highlights the links to the physical sciences, including environmental conditions related to earth and space 2. Ask the students to name a vehicle or system that would be a "good" representative example for each of the four environments 3. Identify some of challenges involved in each environment (such as the hazards of crossing the Atlantic Ocean or flying in thunderstorms) 4. Show a video that features one or more of the modes with transportation 5. If time allows, describe some local facilities used for each mode (i.e., an airport, waterway, race track, etc.)
2-5	Cover land-based transportation 1. Introduce the practice of using technology to enhance travel on or under the surface of the earth 2. Provide example of common land-based vehicles or systems such as . . . . ● Underground pipelines ● Subways

- Interstate highways
- Bus and taxi routes
- Recreational vehicles (mountain bikes, skateboards, etc.)
- Semi-tractor trailer (diesel) trucks
- Railroads
- Motorcycles
- Raceways / tracks

3. Determine a competitive race that could be implemented in the classroom that involves a land-based technology, such as . . . . .
   - Race CO2 cars in a hallway or on a track
   - Designing and racing vehicles on a maglev track
   - Race battery- or solar-powered cars
   - Create 2- or 4-wheel drive vehicles with Lego's, Radio Shack kits, K'Nex, erector-set kits, etc.
   - Mouse rap cars
   - Other
4. Challenge the students (in small teams) to design, build, and race their vehicles . . . . .
   - Establish competitive guidelines
   - Identify the race course / track
   - Review paperwork that should be completed by each team (ideation forms, planning charts, sketching worksheets, a bill of materials, etc.)
   - Prepare supplies, tools, etc. for each team
   - Cover safety guidelines before students use tools and / or equipment to fabricate their vehicles
   - Introduce the testing (evaluation) procedures
5. Provide time for the students to develop and test their vehicles
6. Conduct the race with each team having one, two, or more trials to establish a best time or distance
7. Following the races, summarize the competition by identifying the characteristics of the better versus the less efficient designs
8. Collect all paperwork and vehicles for formal evaluation

6-10 Introduce the nature of traveling on or under the surface of water

1. Outline the historical importance of crossing seas or oceans, or traveling up and down navigable rivers
2. Review the examples of "environments" associated with water-based transportation
   - Lakes
   - Ponds
   - Rivers / streams
   - Canals
   - Lock systems

Day Instructional Outline (Lessons / Activities / Notes)

- Open waterways (oceans, seas, straits, etc.)
- Harbors / ports

Note: Social studies concepts should be addressed at this point

3. Split the class into small groups (with teams different from the first activity involving land transportation)
4. Provide a waterway (long trough, deep sink, large basin, etc.) for the students to use to test their watercraft
   Note: This activity is designed to involve boats or watercraft to go across the top of the water, but an activity involving a submersible could be implemented here
5. Describe how to build a vessel, identifying the major concepts involved with the watercraft including . . . .
   - Buoyancy
   - Draft / displacement
   - Hull design
   - Internal versus external propulsion systems
   - Other

   Note: Several of these topics relate to science content, especially physics
6. Challenge each team create a vessel that can cross the waterway using a box fan or compressed air as the source of propulsion . . . so a sail will be required for the vehicle
7. For variety, different types of hull designs (mono-hull, flat-bottom hull, wedge-shaped hull, etc.) might be assigned to the different teams
8. Have the teams design and build a vessel using Styrofoam, cardboard, dowels, small weights, etc. (covering the bottom of their craft with aluminum foil or waxed-paper)
9. Have the groups demonstrate their vehicles in the waterway as they race across the water to the opposite end of the basin
10. Summarize the success of the different vessels, especially in relationship to the key terms and definitions covered earlier in the activity

11-13 Review the challenge of traveling through the atmosphere

1. Collect pictures of aircraft from past eras (bi-planes, hot air balloons, gliders, jets, etc.), noting the advancements in aircraft and performance (speed, distance, carrying-capacity, etc.)
2. Explain how aviation pioneers solved the early problems associated with powered flight
3. Cite categories of aircraft
   - Lighter-than-air (balloons, dirigibles, etc.)
   - Heavier-than-air (both fixed wings versus rotary wings)
   - Manned versus un-manned
   - Propeller versus jet powered

Day Instructional Outline (Lessons / Activities / Notes)

4. Review the four elements of modern flight:
   - Thrust
   - Drag
   - Lift
   - Gravity

   Note: Highlight the relationship of science themes during this lesson
5. Have the students build a rubber-band powered (balsa wood) flyer
6. Provide the time for the students test-fly their model aircraft
7. Discuss various ways to enhance the models, such as changing the center of gravity, altering the size of wings, change the size of the propeller, etc.

14-18 Explore the nature in space transportation technology

1. Outline the challenges of leaving the earth's gravitational field and traveling through space . . .
   - Propulsion systems
   - Structural components
   - Navigation
   - Hazards in outer space
   - Distances involved in communication
   - Optimal alignment of planets / orbits
   - Training of astronauts
2. Use a video of a manned or un-manned mission to illustrate the development of space rockets or vehicles
3. Have the students create models of rockets that can be launched near the school (either with solid motors or a compressed fluid) such as . . . .
   - Paper models launched with blasts of air
   - Commercially available kits (with solid rocket engines)
   - Water-powered rockets made from plastic soda bottles
   - Other
4. Cover safety guidelines before using any materials, equipment, and (especially!) rocket motors
5. Schedule and conduct a class session(s) to launch the model rockets

19-20 Explore examples of intermodal transportation

1. Identify local examples of facilities used to load, transfer, or unload international containers
2. Use commercial WWW sites to introduce the services available for the transportation of shipping containers
   - Triple Crown Services (based in Ft. Wayne, IN, and using Wabash trailers built in Lafayette, IN)
   - Global shippers such as Hanjin, Maersk, Hapag-Lloyd, APL, etc.

Day Instructional Outline (Lessons / Activities / Notes)

- Local loading / unloading facilities (terminals)
- Container ships
- Distance ports

3. Ask the students to report the times, costs, etc. involved in transporting a shipping container to another part of the world
4. To conclude the unit, collect the developed materials for evaluation
5. Develop and give a quiz or test over content covered during the unit

Evaluation

Students may be evaluated on these actions and related criteria . . . .

- ✔ Participation in classroom and laboratory activities
- ✔ Completion of model aircraft, vessels, rockets, etc.
- ✔ Following a structured problem solving process (as reflected in documentation, sketches, etc.)
- ✔ Final results from competitive events
- ✔ Scores on teacher-created tests and quizzes

Unit 3 / 35 Days

Vehicular Systems

Transportation vehicles have six major technical systems that allow them to operate efficiently in a given environment. The level of complexity of these technical systems is directly related to the challenge of the physical environment itself. The greater the degree of freedom a given vehicle has the greater the interaction and more complex the technical system becomes. The technical systems involved in bicycle travel are very simple compared to that required to flying a commercial jet airliner halfway around the globe. In the same way a hot air balloon has a much simpler set of technical systems than the International Space Station.

There are five basic technical systems that are directly part of the transportation process: structure, propulsion, control, guidance, and suspension. The sixth basic technical system, support, is indirectly linked to the transportation process. These technical systems are described as follows:

- Structure — A framework or container within which to install the other systems and to protect the passengers and / or cargo during transit
- Propulsion — A method of converting and transmitting energy for movement of the vehicle
- Control — A method of acceleration, deceleration, and changing the direction, altitude, and / or attitude of the vehicle
- Guidance — Information used for controlling the vehicle and determining the path and rate to travel
- Suspension — A method to smooth the ride and protect the vehicle and passengers / cargo
- Support — Personnel and facilities needed to operate the vehicle (fuel, safety systems, guideways, terminals, maintenance, etc.)

It is the interaction and operation of these systems that allow for the movement of passengers and goods. The more efficient these systems are, the more practical and usefulness the transportation activity becomes. In this unit the technical systems will be presented and explored through a series of discussions and laboratory activities.

Each technical systems will be looked at individually and an activity will be used to reinforce the basic concepts. It should be stressed however that these technical systems are interactive with each other and that the operations and changes that take place in one will influence what happens in the others. So while a different mode of transportation will be used for each element, it should be noted one vehicle could be used to illustrate the major concepts.

Objectives

Upon completing this unit each student will be able to:

- ✔ Define what is meant by a vehicular sub-system
- ✔ Explain each of the major technical systems
- ✔ Differentiate between control and guidance
- ✔ Identify in a given vehicle the six basic technical systems
- ✔ List and describe the types of support systems needed to operate a transportation vehicle or system

Proposed Schedule For The Unit

Day	Content / Activities
1	Introduce vehicular sub-systems
2-5	Review structural design
6-15	Explore propulsion systems
16-20	Examine control systems
21-25	Review guidance systems
26-30	Examine suspension systems
31-35	Cover support systems in transportation

Outline For Unit #3

Day	Instructional Outline (Lessons / Activities / Notes)
1	Address the theme of “technical sub-systems” in vehicular design 1. All transportation vehicles incorporate the six technical systems in some way or another . . . . ● Structure (framework of vehicle) ● Propulsion (energy conversion and transmission) ● Control (speed, direction, altitude, and attitude changes) ● Guidance (information used for controlling the vehicle) ● Suspension (ride, forces, etc.) ● Support (personnel and facilities) 2. Note that the more degrees of freedom (areas of movement) a vehicle probably has a more complex and integrated set of sub-systems to account for the variety of forces and directions

Day Instructional Outline (Lessons / Activities / Notes)

3. Name several common vehicles (from both passenger and freight modes) and challenge the students to identify the six basic technical systems in each vehicle
4. Ask the students to also outline the inter-relationship of the systems that are being discussed
5. Identify area businesses that might support transportation in the community (especially in regards to the vehicles under analysis)

2-5 Introduce the concept of structural systems in vehicular design

1. Review examples of vehicular “structures” in different applications
   - Fixed (elevator, escalator, conveyors, etc.)
   - Moving (car frames, boat hull, fuselage in aircraft, etc.)
2. Cover related design considerations
   - Human factors
   - Safety
   - Environmental concerns
   - Performance / efficiency
   - Economic factors
3. To initiate an activity that covers structural elements, install an inclined ramp in the classroom or laboratory (such as a long board from a benchtop to a solid wall or piece of furniture on the floor)
4. Challenge the students to design and build a vehicle that will protect an egg that is transported down the ramp via gravity
   - Provide guidelines for the vehicle based on the size of wheels, width of the ramp, etc.
   - Specify how the egg may be restrained, but not permanently attached to the vehicle

   Note: Assume that the fragile egg is the “passenger” on the vehicle, and obviously it (i.e., the “occupant”) must be protected from the impending impact at the bottom of the ramp
5. Cover safety rules and appropriate laboratory procedures for building the vehicles
6. Conduct a testing session to determine if the structural components of the vehicles do “work” (or function) properly
7. Summarize the effective materials and design that worked the best

6-15 Introduce propulsion as a major vehicular sub-system

1. Identify the power and energy principles involved in modern transportation
2. Provide an overview of internal and external combustion engines
   - Mechanical
   - Chemical
   - Electrical

Day Instructional Outline (Lessons / Activities / Notes)

- Hybrid
- Other

3. Discuss examples of energy transmission techniques
   - Mechanical drive (belts, gearing, etc.)
   - Hydraulic (automatic transmissions, etc.)
   - Reactionary (water jet, blasts of air, rocket power, etc.)
   - Nature (gravity slides, dropping, etc.)
4. Have the students explore several of the "how it works" types of websites on the Internet to explore propulsion systems
5. Implement an activity based on propulsion systems, such as . . .
   - Install a rubber-band drive or small battery-powered motor on the vehicle used during the egg-activity so that the vehicle can run "up" the same ramp
   - Tear apart a small lawn mower engine and put it back together, noting the various parts and systems in the motor
   - Challenge the students to create a hovercraft with small portable vacuums (one for lift, the other for propulsion)
   - Place a floatable craft in a water tank, install a sail, and attempt to propel the vessels around the water with a blast of air
   - Other

   Note: Due to the many forces involved (inertia, actions and reactions, etc.) there are numerous links to physics in this activity
6. Test the vehicles or systems, with the students evaluating the power, economy, etc. of the force
7. Disassemble items, put resources away, and / or clean-up the work area at the conclusion of the activity

16-20 Introduce the nature of control techniques in vehicular systems

1. Review the definition of control, which is acting upon the information provided by guidance systems to maneuver a craft (such as to brake when a traffic signal turns red)
2. Review examples of "what" can be controlled in modern transportation
   - Velocity (acceleration versus deceleration)
   - Directional (forward and reverse, left and right, etc.)
   - Depth or altitude (height for aircraft, total depth for submarines)
   - Attitude (pitch, roll, and yaw in aviation)
3. Identify the methods of controlling a vehicle as they travel in various environments
   - On-board controls – steering, braking, throttle, pre-programmed computers, etc.
   - Off-board controls – RC (remote control) vehicles, physical guideways, the glide slope provided by instrument landing systems, etc.

Day Instructional Outline (Lessons / Activities / Notes)

4. Challenge the students to control an aircraft in flight using either paper models or a flight simulation software
   - Identify surfaces that help direct an aircraft during flight
   - Demonstrate how to use the software or develop the model(s)
   - Attempt to maintain a set altitude (height) during a short flight, or to land on a designated runway
   - Discuss the input (information) necessary to fly the craft in a safe and orderly manner
5. Cover additional forms of control techniques (from other modes of transportation) to conclude the activity

21-25 Cover the concept of guidance in transportation technology

1. Introduce “information” as applied to navigation and guidance . . . .
   - On-board instrumentation (fuel gauges, speedometer, altitude or depth readings, etc.)
   - Communication equipment (radios, radar, sonar, traffic signals, etc.)
   - Automated systems (computers for an auto-pilot, pre-programmed instructions for interplanetary probes, etc.)
   - Other
2. Note the increased challenge of global transportation where foreign languages (verbal commands, radio communication, etc.) are involved
3. Identify common forms of information for personal transportation . . . .
   - Interstate highway maps
   - Maps of airways and waterways
   - Internet websites with maps, charts, etc.
   - Travel planning software
   - Websites of transportation firms (vacation planning, fees for movers, shipping services, etc.)

   Note: Highlight the obvious links to math during this lesson as times and distances are necessary details in any planning
4. Challenge the students to use prepare road maps (i.e., directions) from their local community to other high schools in the conference or region
5. Along with the basic travel maps, add information about (a) restaurants or other locations of importance, (b) alternative routes, and (c) travel times
6. If time allows, have the students design traffic signs for along the planned routes . . . .
   - Road signs for exits from interstate highways
   - Directional signs for key locations around school premises
   - Other

26-30 Introduce “suspension” in vehicular systems

1. Define suspension in terms of transportation technology

Day Instructional Outline (Lessons / Activities / Notes)

2. Review common means of suspension in modern vehicles . . .
   - Mechanical systems – wheels, skids, gears on cog railways, etc.
   - Fluid systems – hydrostatic (i.e., boats in water), hydrodynamic (hydrofoils), etc.
   - Pneumatic systems – aerodynamic lift as found on conventional airplanes in flight
   - Magnetic / electrical systems – maglev technology
   - Other
3. Cover the relationship between propulsion, control, and suspension in each example noted during the class, such as . . . .
   - How railroad wheels are guided around curved track by the rails that are supporting the train
   - The ability to gain speed when going down stream or flying with a strong “push” from the jet stream, as the water or atmosphere (respectfully) are supporting the vehicle
   - Other
4. Challenge the students to create a magnetic levitated vehicle that will excel at a competition, such as fastest (gravity-assisted) or will carry the most weight across a track
   - Set-up a maglev track in the classroom or laboratory
   - Establish an appropriate challenge for the activity based on the number of teams, time available, and related factors
   - Divide the class into small groups for the design contest
   - Review how to safety use tools, equipment, and materials during the activity
   - Allow the teams to design, build, and test their maglev vehicle
   - Conduct the maglev contest, with each teams describing their design work prior to the event trials
   - Identify the “winning” solutions to the challenge and state why or how the design(s) was the optimal solution
5. Summarize how suspension impacts the transportation process with an oral or written review

31-35 Cover support in transportation systems

1. Provide examples of “support” in vehicular design and operation
   - Fueling
   - Maintenance
   - Services at terminals and yards
   - Others

2. Challenge the members of the class to identify support services in the local community, such as:
   - Gas stations

Day Instructional Outline (Lessons / Activities / Notes)

- Repair and detailing specialists
- Street and highway department facilities
- Hangers at area airports
- Loading and unloading equipment

3. On a community map, location and label the sites noted above or others that the students can identify
4. Show a video about modern transportation, with the students listing examples of support activities that are shown in the media
5. In the time available during Unit #3, have the students perform a routine service or maintenance task (such as disassemble an RC vehicle and change a tire, adjust the brakes on a bicycle, lubricate the wheels on a kid's tricycle, tear down and rebuild a small gas engine, refinish a skateboard, etc.)
6. Complete routine tasks around the classroom and laboratory to conclude the unit (putting away equipment, dis-assembly of vehicles or test tracks, etc
7. Develop and administer a quiz or test at the end of this multi-week unit on vehicular systems

Evaluation

Students may be evaluated on these actions and related criteria . . . .

- ✔ Participation in classroom and laboratory discussions
- ✔ Design of various vehicles
- ✔ Completion of drawings, worksheets, forms, etc.
- ✔ Performance or operation of "new" vehicles
- ✔ Formal or informal explanations over assigned topics
- ✔ Scores on teacher-created tests and quizzes

Unit 4 / 10 Days

Developing Transportation Systems

Technology can be described as the use of tools, machines, and systems to extend the potential of people to control the natural and human-made environments. All technological systems have a common structure. They develop from a need or desire and are produced for use by a consumer.

Transportation “systems” are no different from any other technological system. They are developed out of the need for movement and the constant desire for faster, cleaner, more economical means of getting people and cargo from one point to another. They are established and run by private individuals, small companies, large corporations, and governments. Transportation systems are routinely analyzed for their value and impact by consumers, who also determines their safety, economics, public acceptance, or potential damage to the environment.

The development of transportation systems falls under the category of “design” and “operations” within both government and business. It is during formal Research and Development (R&D) that transportation vehicles and systems are designed and tested. The development of a transportation system actually begins with a need or opportunity of some type. This can be as simple as a desire to move something quicker or as complex as new regulations set up by government agencies. To meet these needs a process is followed to develop an acceptable solution. These are called the development steps and include: defining the problem, developing multiple solutions, selecting a solution, modeling the solution, analyzing the solution, and communicating the solution.

Within the development operations there are three major areas in which transportation designing takes place. These include (a) vehicle and system design, (b) facilities and guideway design, and (c) planning routes and schedules. Vehicle and system design deals with the development of specific vehicles (like cars, trucks, etc.) or a specific system for moving passengers and cargo (like elevators and subway networks). Facility and guideway design deal with the development of structures needed for the vehicle or system to operate along with any special track or structure (like railroad lines, city streets, canals, monorails, cables, etc.). A reminder, some facilities are more recreational in nature, such as drag strips and race tracks. Finally, the specific routing and system operations schedules must be planned if the transportation is to be efficient.

During this fourth unit, the focus will be on the design and operation of passenger transportation systems. Instructors should attempt to emphasize the way resources are organized and combined to create an efficient system for the movement of people. In the next unit, the transport of bulk commodities will be highlighted.

Objectives

Upon completing this unit each student will be able to:

- ✔ Define transportation system
- ✔ Explain what is meant by research and development in transportation design and operations
- ✔ Describe several examples of transportation systems in the local community that have been designed and engineered
- ✔ List the steps in the development process and briefly explain each task
- ✔ Apply the development process to address a simple transportation problem and develop a solution
- ✔ Explain the need for routing and scheduling in transportation

Proposed Schedule For The Unit

Day	Content / Activities
1-3	Introduce the unique design activities associated with modern transportation Specify how a common transportation is designed
4-5	Design a passenger-based transportation system
6-8	Plan routes, schedules, etc.
9-10	Review energy needs for a transportation system

Outline For Unit #4

Day	Instructional Outline (Lessons / Activities / Notes)
1-3	Introduce the unit by covering the design process as applied to modern transportation vehicles and systems 1. Review how technological-based problems / opportunities are addressed ● Needs ● Wants / Desires 2. Highlight the steps of the technological problem solving process ● Define the problem / opportunity ● Develop multiple solutions that will address the issue ● Select what appears to be the optimal solution ● Model the solution (that has been selected) ● Analyze the planned solution ● Communicate the optimal solution through technical documentation Note: Many models of the design process are found in technology textbooks and other print media

Day Instructional Outline (Lessons / Activities / Notes)

3. Select one or more examples of large-scale transportation systems that the students can study and analyze . . . .
   - Inner-city bus system
   - The national air traffic control system
   - Subway system in a major city (e.g., the Metro in Washington D.C.)
   - NASA's launch and tracking system for mission with humans on board
   - Package delivery service
   - Other
4. Divide the class into small teams and assign each group (a) the same topic from #3 above or (b) a different topic
5. Discuss where to find information about the topic assigned to the teams
6. Provide time for the teams to investigate their system
7. Have each group prepare a graphic that illustrates their system, such as creating a model on posterboard or developing a PowerPoint visual
8. Require each team to explain their system using the prepared media
9. Collect and evaluate the materials developed by the students

4-5 Design a transportation system for passenger travel

Special note to instructors: This is the first of a 7-day activity, and the software used should be based on the transport of humans (versus the activity found in the next unit, which will focus on moving physical materials)

1. Select a software (simulation, game, etc.) that will allow students to design a transportation vehicle or system, such as . . . .
   - SimCity or similar programs
   - Race car games
   - Railroad simulation software
   - Airport operations games
   - Transportation-related challenges on Internet websites
   - Other appropriate software
2. Divide the class into an appropriate number of groups per the number of available computers and / or software packets
3. During these first 2 days . . . .
   a. Review how to use the programs
   b. Gathering information about the mode of transportation being used
   c. Configure the game to match the available time, number of students in the team, and the optimal level of sophistication
   d. Establish the "challenge" for each group, such as adding a subway system to a large metropolitan area or setting up an airline hub at a medium-sized city
   e. Provide time for the students to create their plans and prepare the system (based on authentic / realistic operations)
   f. Monitor the student efforts during this organizational work

Day Instructional Outline (Lessons / Activities / Notes)

6-8 Plan routes and schedules for the transportation system

1. Based on information / knowledge gained to date, have the teams establish a regular schedule for the transportation of people in their "new" system . . . .
   - Create daily, hourly, etc. connections
   - Develop routes between common hubs or stations
   - Install reliable service
   - Other
2. Have the teams adjust any schedules or routes to optimize the system
   - Eliminate routes that have few riders or lose money
   - Add vehicles (flights, subway cars, etc.) as population centers shift
   - Increase the system to cover a broader area / region
3. Challenge the students to operate their system successfully over a full class period
4. On one day, have the teams describe their system to others in the class
5. Assess which transportation might be the "best" in terms of design, operation, function, practicality, etc.
   Note: There are links to other academic areas in this activity, particularly Social Studies (people, the economy, community development, etc.) and Math (time, distances, costs, etc.)

9-10 Review energy needs for a transportation system

1. Have the teams of students list the vehicles that are used in the systems that they have been operating
2. Challenge the students to learn more about the individual vehicles involved, such as . . . .
   - Type of fuel
   - Average miles per gallon
   - Range with full tanks of fuel
   - Maintenance requirements
   - Governmental over-sight (i.e., is a black box recording system required in each vehicle?)
   - Average cost for a new model
   - Typical life-time in full service
   - Other
3. Using the collected information, have the teams extrapolate the costs of running a typical fleet of vehicles (planes, buses, trains, etc.)
   Note: There are numerous mathematics links involved in this activity
4. Have the students report on their findings, either with a brief oral presentation, with a graphic, or through a homework assignment
5. On the final day, plan to summarize the efficiencies (and obvious waste) of the many vehicles and systems addressed during the unit

Evaluation

Students may be evaluated on these actions and related criteria . . . .

- ✔ Participation in classroom presentations
- ✔ Research into assigned themes / topics
- ✔ Teamwork while developing the transportation system
- ✔ Knowledge of transportation practices
- ✔ Success in setting-up and using transportation software
- ✔ Efficiencies associated with the developed transportation system
- ✔ Informal and formal explanations
- ✔ Ability to follow a technological problem solving process
- ✔ Scores on homework assignments

Unit 5 / 10 Days

Operating Transportation Systems

Modern transportation systems are designed to move people and goods in an efficient manner. These "transporting operations" occur in the private, corporate, and governmental sectors. Success results from using vehicles, terminals, crews, etc. to relocate items from a Point A to a Point B.

The fundamental process of transporting something or someone includes:

- Receiving / storing (such as the waiting area for passengers or the secure area for holding cargo in a warehouse or container yard)
- Routing (establishing the pathway for the vehicle or cargo)
- Loading (placing the cargo in the vehicle or allowing passengers to board the vehicle)
- Moving (the actual relocation of the passengers or the moving of cargo from an origin to a destination)
- Unloading (removing the cargo from the vehicle or allowing the passengers to exit the vehicle)

These five areas of operation are common in every transportation system. They are also interdependent — the failure or holdup in any one of the operations may result in the failure or holdup of the entire system. As transportation systems become more global in nature this interdependency becomes more complex and less forgiving of errors. For instance, mailing a package across country involves many of the same transporting operations as sending astronauts to the international space station. Naturally, the mission to the space station is much more complex and does not allow much room for failures in any of the operations.

During this unit, each of the five elements listed above will be reviewed. Students will be challenged to create a system that reflects the actions of loading, unloading, etc. The major challenge will be in using vehicles and devices to move a bulk commodity.

Objectives

Upon completing this unit each student will be able to:

- ✔ Explain what is meant by "operating" a transportation system
- ✔ List and explain the five elements associated with transportation operations
- ✔ Identify in a given transportation system where and when the five transporting operations take place
- ✔ Install and operate a simple transportation system.
- ✔ Analyze a system in order to determine how to improve efficiency

Proposed Schedule For The Unit

Day	Content / Activities
1-6	Introduction to transportation operations Develop and install a simple transportation system
7-9	Analyze a system to improve efficiency
10	Conclude the unit on transportation operations

Outline For Unit #5

Day	Instructional Outline (Lessons / Activities / Notes)

1-6 Introduce transportation operations

1. Define terms such as loading, routing, receiving, etc.
2. Explain and provide examples of each common transportation task . . . .
   - Receiving / storage
     - ✔ Special needs for cargo, such as refrigeration or protection from moisture
     - ✔ Considerations for crews or passengers, such as life-support systems or convenient waiting areas
     - ✔ Safety considerations
     - ✔ security issues
   - Routing
     - ✔ Personal trips for leisure (recreation) versus work
     - ✔ Commercial trips, including school bus routes and delivery schedules
   - Loading
     - ✔ Random sites or locations
     - ✔ At stations, platforms, terminals, etc.
   - Moving
     - ✔ Movement via a stationary or random-route mode of transportation
   - Unloading
     - ✔ Manual techniques
     - ✔ Human-operated equipment
     - ✔ Automated systems (from scanning and tracking software to sorting machinery)
3. Identify a variety of challenges that could be implemented with the space and resources available in the school . . . .
   - Loading and unloading of a large pile of peanuts (from bins into small containers or vehicles)
   - Moving of a bulk commodity, like sand, over 20-25 feet

Day Instructional Outline (Lessons / Activities / Notes)

- Transportation of sawdust via an automated conveyor system
- Sorting in-coming mail or packages at the school
- Other

4. Complete the planning work for implementing one or more of these challenges over the next week of class, including . . . .
   - Select the activity / activities
   - Create handouts to help in implementing the assignment
   - Locate and assemble resources needed by the teams
   - Split the class into work groups and initiate the assignments
   - Cover safety guidelines for the use of equipment and materials
   - Monitor the students as they develop and install their system
   - Be sure that the planning, installation, etc. is well documented
   - Assist as required during laboratory sessions
5. On the sixth day of Unit #5, ask the students to describe their "new" transportation system during a show-and-tell period
   - Capture digital pictures of each system
   - Collect the paperwork from each team

7-9 Analyze a system to improve efficiency

1. Have the teams "switch" transportation stations, with each group being assigned another device, mechanism, or system
2. Challenge the students to analyze their "new" system for potential improvements
3. Have the student prepare a listing of items that could enhance the design or function of the systems
4. Schedule part of a class period for each team to outline the suggestions to others in the class

10 Conclude the unit on transportation operations

1. Complete the steps required to finalize the unit, such as . . .
   - Disassemble devices built during the assignment
   - Salvage of any laboratory resources
   - Clean-up of spilled materials

Evaluation

Students may be evaluated on these actions and related criteria . . . .

- ✔ Participation during planning and organizational activities
- ✔ Team contributions during the small group activity
- ✔ Success of the transportation operations
- ✔ Ability to analyze a transportation system

Unit 6 / 5 Days

Using & Assessing Transportation Systems

The use of transportation has always been an integral part of society. From the earliest times we have relied on transportation to carry bulk resources, get us to school or work, and to change our world through recreational travel. We have gone from simple bicycles and horse-drawn carts to high speed trains and space shuttles. We live in a time of ever-increasing dependency on modern transportation systems. What used to be considered a luxury (owning a car) is now a necessity. We have become major users (and abusers) of transportation with our need to go faster, farther, and cheaper.

Using transportation should not be a haphazard or random action that just happens to take place, but an informed decision made with an understanding of the available technology and its impacts. It should meet the needs of the user while limiting the impacts on people, society, and the environment. This cannot be accomplished without a thorough understanding of the actions required in using a given transportation vehicle or system. This includes the selecting, operating, servicing, repairing, and disposing of a family car to the selecting and using of public transportation systems. This will in turn led to better transportation vehicles and systems being offered to the user.

The concept of “using” a transportation system is linked to the idea of evaluating or assessing that technology. Just because a given vehicle or system meets the transporting needs of an individual or group does not mean that it fits within the approval of the society, or doesn’t have a negative impact on the environment. This means that the technology must be evaluated according to what is currently appropriate in regards to political, economic, environmental, social, and technological knowledge at the time. The evaluation process includes defining the desired outcomes, developing evaluation criteria, measuring the technology involved, evaluating the data collected, and finally making recommendations of the technology’s use.

During this final unit, students should evaluate a common transportation issue that impacts their daily lives. Two examples would be the bus system used by the school and the number of students who drive to school each day. Other issues might exist in the local community that would be appropriate to focus on at this time.

Objectives

Upon completing this unit each student will be able to:

- ✔ Define what is meant by “using” a transportation system of service
- ✔ Explain what is meant by “assessing” transportation

- ✔ Describe the steps used in assessing transportation systems
- ✔ Explain the importance in being able to evaluate transportation from a personal and corporate perspective
- ✔ Develop criteria and evaluate a given transportation vehicle or system
- ✔ Complete a final examination for the Transportation Systems course

Proposed Schedule For The Unit

Day	Content / Activities
1	Introduce the concept of using transportation systems and services
2-4	Investigate applications of transportation in the local community
5	Complete the final examination for the class

Outline For Unit #6

Day — Instructional Outline (Lessons / Activities / Notes)

1 Introduce the concept of using transportation systems and services

1. Identify the "users" of transportation in today's world
   - Private citizens
   - Communities (towns, cities, etc.)
   - Business and industry
   - Governments
   - Other
2. Explain what is commonly available for "use" by citizens . . .
   - Personal transportation (vehicles like bikes and cars)
   - Mass transit (airports, bus terminals, etc.)
   - Delivery of mail, small parcels, and large-ticket items
   - Moving services
   - Governmental activities, from travel guidelines to road maintenance to military requirements
   - Other
3. Cover the common steps in using a vehicle . . .
   - Select the optimal vehicle
   - Operate the vehicle in a safe manner
   - Service the vehicle
   - Schedule and perform routine maintenance (repair)
   - Dispose of the vehicle in an appropriate manner
4. Highlight the process of using a transportation system or service . . .
   - Determine the optimal system or service provider
   - Schedule the desired trip or transport activity

Day Instructional Outline (Lessons / Activities / Notes)

- Complete the trip / task
- Decide if the transportation activity met criteria for value, service, time constraints, etc.

5. Challenge the students in the class to identify significant “transportation issues” that they feel will impact their lives in the future
6. Highlight the one or more issues that will be the focus of Unit #6 (such as the time students spend on school busses each morning and afternoon, or the number of cars driven to school each day be individual teachers and students)

2-4 Investigate applications of transportation in the local community

1. Select a major transportation topic and have students (individually or in small teams) determine an appropriate solution to the challenge
2. Several major themes that would be found in every school include . . . . .
   - School and municipal bus systems are used to transport students to and from school, often requiring students to be on a bus for up to two hours per day
   - Cars are the preferred means of transportation for teachers and high school students, often with one person per vehicle (resulting in a need for large parking lots, and obviously with a large waste of fuel)
   - Other
3. Challenge the students to study the “problems” associated with their transportation issue and propose a solution following these steps . . .
   a. Review the need for and the desired outcomes of the transportation technology / system
   b. Establish how to measure (rate) the success of the transportation vehicle, service, or system
   c. Apply the rating criteria to determine the current level of performance, function, etc.
      Note: This process involves numerous links to social studies and math
   d. Evaluate and propose changes in the current transportation topic, all based of statistics and information available from official sources
   e. Provide time for the students to fully develop their plans and prepare the report on the improved scenario
   f. Be sure the students use their rating criteria to also assess their proposed plan
   g. Have the students report their findings and make recommendations
      Note: It’s often “fun” to invite authorities from the school to participate in these reporting sessions, as the students may be able to share some very useful suggestions
   h. Have the students report their findings and make recommendations
   i. Collect and evaluate the student-developed materials / ideas

Day Instructional Outline (Lessons / Activities / Notes)

4. Invite any guests to comment on the proposed plans
5. As time allows, review the practicality of the proposals with all members of the class

5 Complete the Transportation Systems course

1. Finalize any classroom or laboratory tasks that are required to complete the course
2. Develop and give a final examination to assess student learning

Evaluation

Students may be evaluated on these actions and related criteria . . . .

- ✔ Involvement during classroom and laboratory activities
- ✔ Following a structured using and assessing model to evaluate a local transportation issue
- ✔ Research into a transportation vehicle, service, or system
- ✔ Proposed enhancement of an existing plan or issue
- ✔ Nature of charts, graphs, etc. that explains a transportation issue
- ✔ Quality of a formal presentation
- ✔ Scores on teacher-created final examination

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